

Seed Coat and Pericarp Anatomy in Some Heliantheae (Asteraceae)

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ヒマワリ亜連（キク科）数種の種皮の構造

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Mature pericarp of *Encelia*, *Enceliopsis*, *Helianthus*, *Simsia*, *Viguiera* and *Tithonia* consists of five distinct zones: epidermis, hypodermis, phytomelanin layer, fibre zone and parenchymatous zone. In *Lagascea*, *Verbesina* and *Zexmenia* pericarp is differentiated into four zones and the inner most parenchymatous zone is absent. Epidermal cells of the seed coat show fibrous thickenings in *Encelia*, *Enceliopsis*, *Verbesina* and *Zexmenia*. Present study suggests placement of *Lagascea* in subtribe Ecliptinae and placement of *Encelia* and *Enceliopsis* in subtribe Helianthinae.

Subtribal grouping of taxa within Heliantheae has received considerable attention of several systematists. Hoffmann (1890) recognised 11 subtribes within Heliantheae. Stuessy (1977) added four new subtribes. Robinson (1981), however, recognised 35 subtribes within tribe Heliantheae. In Hoffmann's (1890) classification of Heliantheae, subtribe Helianthinae was the largest subtribe with about 82 genera. Stuessy (1977) divided subtribe Helianthinae into three subtribes; Ecliptinae, Helianthinae and Verbesinae. Robinson (1981), on the other hand, sub-divided Hoffmann's Helianthinae in only two subtribes; Helianthinae and Ecliptinae.

The objectives of the present paper are to: (i) describe achene anatomy in members of subtribes

Helianthinae and Verbesinae and (ii) comment on the systematic position of taxa grouped in the above subtribes.

Materials and methods

Materials for the present study were obtained from seed herbarium of the National Botanical Research Institute, Lucknow and Herbarium of the Ohio State University, Columbus (Table 1). Mature achenes were kept in 70% ethyl alcohol for a week. Customary methods of dehydration in tertiary-butyl-alcohol series and embedding in paraffin wax were followed. Microtome sections, cut between 16–22 μ m thickness, were stained in safranin-fast green combination. Mature seed coat, dissected out from the mature achenes, were

Table 1. Taxa and Vouchers.

<i>Lagascea mollis</i> Cav.	Amita 1538
<i>Verbesina alternifolia</i> (L.)	Britt Landy 739
<i>V. nelidae</i> Cabrera	Cabrera 13005
<i>Zexmenia hispida</i> (H.B.K.) A. Gray	Stuessy 105
<i>Z. arnotii</i> (Baker) Hassler	Bolcke 128
<i>Encelia farinosa</i> Gray	Mahler & Thieret 5439
<i>E. frutescence</i> Gray	Mehill & Lehta 10683 (OS)
<i>Enceliopsis nudicaulis</i> (A. Gray) A. Nels.	Keil 10843
<i>Helianthus annuus</i> Linnaeus	Burkart 23574
<i>H. decapetalus</i> L.	Pandey 1125
<i>Simsia ghiesbreghtii</i> (A. Gray) S.F. Blake	Spooner & Dorando 2675
<i>S. fruticulosa</i> (Sprengel) S.F. Blake	Spooner & Guerara 2923
<i>S. molinae</i> Robinson et R.D. Brettell	Spooner & Dorado 2701
<i>S. tenuis</i> (Fernald) S.F. Blake	Spooner & Villasenor 2550
<i>Tithonia tubaeformis</i> (Jacq.) Cass	Pandey 1170
<i>Tithonia rotundifolia</i> (Mill.) Blake	Arenas 1152
<i>Viguiera guaranitica</i> Chodati	Arenas 1153

studied for thickening pattern.

Observations

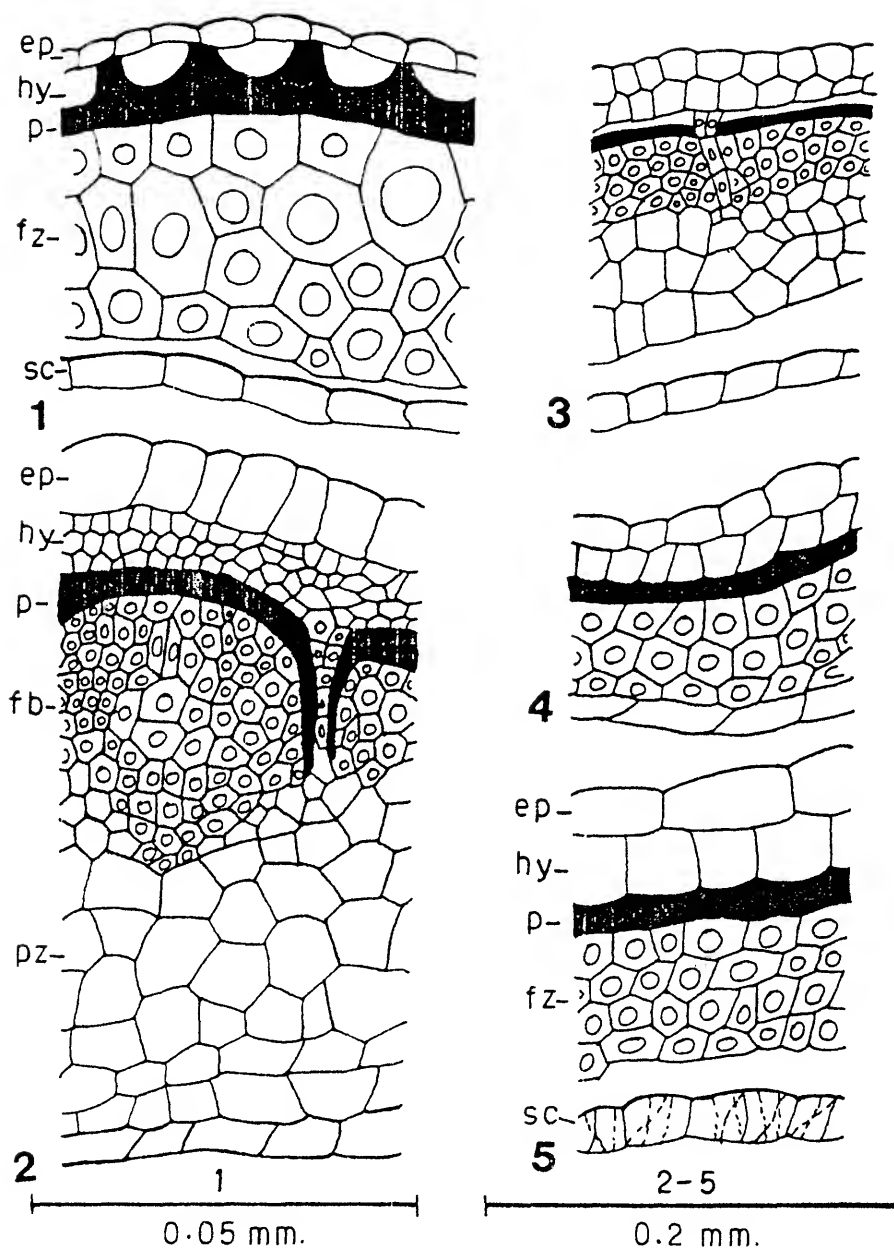
Pericarp: In *Lagascea*, *Verbesina* and *Zexmenia* the mature pericarp is distinguishable into four distinct zones: epidermis, hypodermis, phytomelanin layer and fibre zone (Figs. 1, 5). In *Encelia*, *Enceliopsis*, *Helianthus*, *Simsia*, *Tithonia*

and *Viguiera* on the other hand, the mature pericarp is distinguishable into five distinct zones, epidermis, hypodermis, phytomelanin layer, fibre zone and parenchymatous zone (Figs. 2, 3, 4). The epidermis is single-layered followed by hypodermal cells. The number of hypodermal cell-layers, however, varies. In *Encelia*, *Enceliopsis*, *Lagascea*, *Simsia*, *Viguiera*, *Tithonia* and *Zexmenia* it is single layered, while in *Verbesina* hypodermis is 3–4 layers thick (Table 2). In *Helianthus* the hypodermal zone is 6–8 layers thick (Fig. 2). The cells of hypodermis are radially elongated. The characteristic phytomelanin layer is present just below the hypodermal zone in all the genera. The phytomelanin-layer is continuous in *Encelia*, *Enceliopsis*, *Verbesina*, *Zexmenia* and *Lagascea* (Figs. 1, 4, 5) but is discontinuous in *Helianthus*, *Simsia*, *Tithonia* and *Viguiera* due to presence of uni- or bi-seriately arranged ray-like parenchymatous trabeculae (Figs. 2, 3). Phytomelanin layer is underlain by fibre zone which is in the form of fibre bundles in *Simsia*, *Viguiera*, *Tithonia* and *Helianthus*. Each fibre-bundle is 3–4-layers thick in *Simsia* and *Viguiera* and 6–8-layers thick in *Helianthus* and *Tithonia*. In *Encelia*, *Enceliopsis*, *Lagascea*, *Verbesina* and *Zexmenia* the fibre zone is continuous and 2–3-layers thick. The parenchymatous zone is present only in *Encelia*, *Enceliopsis*, *Helianthus*, *Simsia*, *Tithonia* and *Viguiera* (Table 2). It consists of 1–4-layers of loosely arranged parenchymatous cells.

Seed coat: The seed coat in all the presently studied genera is 1–2 cell-layers thick. In *Verbesina*, *Zexmenia* (Fig. 5), *Encelia* and *Enceliopsis* the epidermal cells of seed coat show fibrous thickenings. Such thickenings are absent in *Simsia*, *Viguiera*, *Tithonia*, *Helianthus* and *Lagascea* (Figs. 1, 3).

Discussion

Stuessy (1977) placed *Lagascea*, *Verbesina* and



Figs. 1-5: Achene anatomy of some genera of Heliantheae. 1. *Lagascea mollis*. 2. *Helianthus decapetalus*. 3. *Simsia tenuis*. 4. *Encelia frutescence*. 5. *Zexmenia hispida*. ep: epidermis, hy: hypodermis, fb: fibre bundle, fz: fibre zone, p: phytomelanin layer, pz: parenchymatous zone, sc: seed coat.

Zexmenia together in subtribe Verbesininae but Robinson (1981) dismantled subtribe Verbesininae and placed *Verbesina* and *Zexmenia* in subtribe

Ecliptinae together with *Eclipta* and *Wedelia* and *Lagascea* in subtribe Helianthininae.

Present observations support placement of

Table 2. Comparison of pericarp and seed coat anatomy.

Taxa	Hypodermis	Pericarp		Parenchymatous zone	Seed coat thickenings (+/-)
	(No. of layers)	Phytomelanin layer	Fibrous zone		
<i>Verbesina</i>	4	cont.	cont.	—	+
<i>Lagascea</i>	1	cont.	cont.	—	—
<i>Zexmenia</i>	1	cont.	cont.	—	+
<i>Encelia</i>	1	cont.	cont.	+	+
<i>Enceliopsis</i>	1	cont.	cont.	+	+
<i>Simsia</i>	1	discont.	discont.	+	—
<i>Viguiera</i>	1	discont.	discont.	+	—
<i>Tithonia</i>	1	discont.	discont.	+	—
<i>Helianthus</i>	6–8	discont.	discont.	+	—

cont.: continuous, discont.: discontinuous, +: present, —: absent.

Verbesina and *Zexmenia* in Ecliptinae as it shares many features of *Eclipta* and *Wedelia* (Pandey and Jha unpublished). *Lagascea*, however, differs from the members of Ecliptinae in absence of thickenings in seed coat cells but pericarp anatomical characters resemble to a great extent with those of the other members of Ecliptinae (Pandey and Jha unpublished). We thus suggest the placement of *Lagascea* in subtribe Ecliptinae together with *Verbesina* and other members of this subtribe.

Encelia and *Enceliopsis* placed in subtribe Helianthinae by Stuessy (1977) together with *Helianthus*, *Simsia*, *Tithonia* and *Viguiera* show a similar basic pattern of seed coat and pericarp differentiation. These genera differ from other members of Helianthinae in characters like (i) presence of continuous phytomelanin layer (ii) presence of continuous fibre zone and (iii) presence of fibrous thickening in the seed coat cells. Morphological characters of *Encelia* and *Enceliopsis* resemble to a great extent with other members of subtribe Helianthinae, therefore, we support place-

ment of these genera in subtribe Helianthinae as has been done by Stuessy (1977). *Encelia* and *Enceliopsis*, however, deserve placement in a separate group within Helianthinae.

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